

## STRATEGIES FOR MANAGING MANGROVE ECOSYSTEMS

Mangrove wetlands are widely recognized as one of the most important and productive coastal habitats in the tropics. Mangroves played an important role in sustaining the livelihoods and cultures of many pre-Columbian coastal communities in Ecuador—such as “La Tolita” in the northwest section of the country, where development centered around a mangrove forest. After the colonial period, mangroves provided wood for shipbuilding and bark to produce tannin for curing leather. In this century, mangroves remain a source of firewood, charcoal, and lumber for construction of piers, houses, bridges, and for woodworking. Mangroves have always provided the habitat for fish and shellfish that thousands of coastal residents depend upon for personal consumption and for income.

In addition, mangrove ecosystems play an important role in maintaining water quality in estuaries, protecting shoreline from storm damage and erosion, production and export of organic matter from estuaries, and retention of sediments and heavy metals in estuarine waters.

The past three decades have brought destruction and overuse of mangrove wetlands and forest, due to population growth, urbanization, and the construction of shrimp farms. This in turn has diminished the ability of these systems to provide food, materials, and energy—benefits that are now more important than ever to coastal residents, many of whom have few practical alternatives for meeting basic needs and earning income.

Since 1979, Ecuador has been searching for a viable mangrove policy: one that would allow for the use of the ecosystem without damage to ecological processes and biodiversity, and that would provide for improvement to the quality of life of surrounding communities. Many laws, regulations, and interministerial agreements have been published to regulate and prohibit the conversion of mangroves to other uses, but the result of these measures has not been encouraging. More than 40,000 hectares (ha) of mangroves have been converted to shrimp farms, and indiscriminate cutting continues.

Since 1986, Ecuador's Coastal Resources Management Program (PMRC) has been exploring alternative approaches to management that take into account the wide variability in the physical characteristics of mangrove ecosystems, and that recognize the economic and social self-interest of coastal communities and resource users. The central role of the PMRC has been to develop a body of experience on how to govern mangrove ecosystems for sustainable use through tests of innovative policies and techniques to create capacity for local mangrove stewardship. Many of the ideas generated from this experience appear to offer Ecuador new hope in designing sound national mangrove management policies that can be put into action through local leadership and collaboration.

## MANGROVE ECOSYSTEM CHARACTERISTICS AND MANAGEMENT ISSUES IN ECUADOR

### Mangroves characteristics important to management

Mangrove is a broad term used to describe about 50 species of trees worldwide that are adapted to grow in salt water. As many as 15 of these are found in Latin America. There are five important species that make up Ecuador's 162,055 remaining hectares of mangrove forest:

Family or genera	Common name
<i>Rhizophora</i>	Red mangrove
<i>Avicennia</i>	Black mangrove
<i>Laguncularia</i>	White mangrove
<i>Conocarpus</i>	Mangle jeli
<i>Pelliceria</i>	Pinuelo

# **EIGHT YEARS IN ECUADOR: THE ROAD TO INTEGRATED COASTAL MANAGEMENT**

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Mangrove forests are found in three types of intertidal zone settings.

**River mangrove** forests are located along edges of coastal rivers, as far upstream as the last point of intrusion of salt water. The flow of river water provides rich nutrients that enable river mangroves to generate thick forest cover. There are about 13,000 ha of this forest type in Ecuador.

**Basin mangroves** are found in the interior of the coast adjacent to salt flats, and receive water intermittently from high tides. Growth is more restricted in this zone, which includes about 40,000 ha in Ecuador, primarily *Avicennia* and *Conocarpus*.

**Fringing mangroves** are flooded with salt water during each high tide. Forest production is high here due to the inflow of nutrients and sediments circulating in estuaries. *Rhizophora* is the predominant species in this setting, which accounts for 77 percent of the mangrove ecosystem in Ecuador, or about 125,400 ha.

Mangroves provide food and habitat to a variety of trophic levels, including important estuary-dependent species of fish, mollusks, and crustaceans. These include:

Scientific name	Common name
<i>Anadara tuberculosa</i>	conch
<i>Anadara similis</i>	conch
<i>Crassostrea columbiensis</i>	oyster
<i>Myella guyanensis</i>	estuary mussel
<i>Cardisona crasum</i>	crab
<i>Mugil spp.</i>	lisa (fish)
<i>Ucides occidentalis</i>	red mangrove crab
<i>Penaeidae (californiensis, vannamei, stylirostris)</i>	white shrimp

The contribution of mangroves to secondary productivity of coastal ecosystems is dependent on the fate of leaf litter, including production in the forest, transport to the estuary, and utilization by marine food webs. Variation among the mangrove systems in Ecuador is considerable, ranging from the high tidal amplitude and large river discharge in northern Esmeraldas and the Guayas River, to arid environments with minor tides and little freshwater input—such as the Rio Chone in Manabí province, and the northern Santa Elena peninsula in Guayas province.

#### Critical mangrove ecosystem management issues in Ecuador

- Destruction of mangrove ecosystems continues at an accelerated pace.

Since 1969, Ecuador has lost 42,000 of its estimated 204,000 ha of mangrove forest cover, primarily to the shrimp mariculture industry (CLIRSEN, 1992). This nationwide average loss of 20 percent does not reflect the fact that most estuaries have actually received much higher rates of damage, and that the comprehensive data compiled by the Center for Remote Sensing (CLIRSEN) for 1969, 1984, 1987, and 1991 do not include associated intertidal areas that have also been filled, diked, or channelized. Destruction includes not only the permanent loss of forest cover, but also the underlying riverine, basin, and fringe mangrove environments that serve as habitat and fishing grounds.

Mangrove loss fall into two categories: the elimination of 95 percent of the basin mangroves; and site-specific losses that range from 3.5 percent to as much as 82 percent of the mangroves of individual estuaries.

The extent and impact of conversion of mangroves to other uses varies considerably among the principal estuaries. In Esmeraldas, the zone of the Santiago-Cayapas-Mataje rivers records a total loss of only 3.5 percent, but this area is currently one of the most threatened, due to recent, often illegal, construction of shrimp farms. Water quality problems and diseases afflicting shrimp farms

in the south now endanger what are considered to be the oldest, largest *Rhizophora* mangroves on the Pacific coast, with heights to 50 meters (m) and diameters of up to 1 m. This area was also the location of the first large-scale destruction of mangroves for coconut palm plantations in the early 1940s, as well as the site of livestock production and urban growth.

Shrimp farm construction has devastated other major estuaries in Manabí province, such as Bolívar-Chamanga-Cojimíes, which has suffered a 51 percent loss, and the Rio Chone, which has lost more than 80 percent.

The Guayas estuary has a total of 130,000 ha of mangroves, along with about 124,000 ha of shrimp farms in the surrounding provinces of Guayas and El Oro. It is the largest estuary on the Pacific coast of South America. It has an extensive river flow, a tidal range of 3 m, and heavy sedimentation. The estuary manages to support shrimp in every stage of the lifecycle, as well as the shrimp mariculture industry itself, and extensive artisanal finfish, mollusk, and crustacean fisheries—all while receiving the raw wastewater discharges of more than 2 million people living in the cities of Guayaquil and Machala. In addition, it handles most waterborne commerce into the country, requiring frequent dredging and disposal of contaminated sediments. The estuary also receives the runoff of nearly half of the agricultural production of the coastal provinces. The Daule-Peripe dam, constructed in 1988, is intended to provide irrigation for up to 100,000 ha. The resulting diversion of water is reducing freshwater flow to the estuary.

According to CLIRSEN studies, Guayas and El Oro provinces have lost only 18 percent of mangrove forest cover. But this picture changes when subregions of the Guayas estuary are more carefully examined. The good news is that the 12,209-ha area near Churute has lost only about 4.3 percent, thanks to forceful implementation of the Ecological Reserve status given it in 1978. Both Taura, which has 19,583 ha, and the Estero Salado, with 40,846 ha, have lost 12 percent of forest cover to urban expansion around Guayaquil, as well as to mariculture. Throughout the Guayas estuary, shrimp farms have spilled over from their initial development in *salinas* (salt flats), which have virtually disappeared, into the *esteros* (tidal inlets), estuaries, and upland sites. The 11,833 ha of mangroves in Naranjal estuary, on the border of Guayas and El Oro provinces, has lost 25 percent of cover, while Jambelí has just 5,625 ha remaining, suffering a decline of more than 52 percent. The Hualtaco region, comprising 13,630 ha in the southernmost section of El Oro, has also lost more than 25 percent of its cover since the inception of the mariculture industry there in the late 1960s.

- Ecuador's mangrove governance policies focus on centralized enforcement of a virtual prohibition of mangrove uses.

The overall pace of destruction has actually increased since tougher mangrove policies and regulations were adopted in the mid-1980s, as documented by CLIRSEN:

Period	Loss per year (ha)
1969–1984	1,439
1984–1987	2,434
1987–1991	3,348

Ecuador turned its attention to managing mangrove forest when the shrimp mariculture industry was just beginning its rapid expansion in the 1970s. In 1978, the National Forestry Directorate published Decree 2939 (Official Register 596 of October 23, 1978), which prohibited the use of mangrove forest for shrimp farm construction, and required zoning plans to be prepared for any site where mangrove cutting would take place. Such cutting was to be carefully planned and accompanied by reforestation. Agriculture interests promoted the requirement that shrimp farms could not be constructed in coastal land suitable for farming. The following year, the Churute Mangrove Reserve was established through a Ministerial Agreement (Number 322, Official Register 69 of November 20, 1979). Two years later, the forestry law provided for controlling the cutting, transportation, and export of mangroves. The Navy was empowered to confiscate boats and cargo of illegally cut mangrove logs.



Publication of CLIRSEN's first comparison of mangrove forest cover between 1969 and 1984 revealed the extensive damage caused by mariculture development and urbanization on detailed maps at a scale of 1:25,000. Some 21,587 ha of mangrove forest had been lost. The government of Ecuador responded swiftly through Executive Decree 824 (Official Register 64 of June 24, 1985), which declared it was in the public interest to conserve, protect, and restore all mangroves. This also made the traditional uses of mangroves practiced in coastal communities illegal. The Fisheries Law of the same year prohibited destroying or altering mangroves and forbid installation of mariculture ponds in mangroves. The accompanying regulations on cultivation of aquatic species in 1985 obligated shrimp farm owners to monitor and protect mangroves, and agricultural lands adjacent to their farms. This language is included in each published shrimp farm concession.

With the exception of the Ecological Reserve in Churute, the government of Ecuador did not add any new financial or administrative resources to put mangrove conservation laws and regulations into action. It takes seven full-time people, along with a travel budget, information centers, and continuous patrols to take good care of the Churute Reserve, which represents a mere 7.5 percent of the total mangrove resource. Only 10 staff are available to work part-time on mangrove management for the entire remainder of the coast.

In the 1993 Workshop on Mangrove Management sponsored by the Ecuadorian Navy, the National Forestry Institute, and the PMRC, a working group on legal aspects concluded:

The revision of Ecuadorian law has created a legal regime in which the proliferation of often contradictory rules actually impedes law enforcement and makes the job of the agencies with jurisdiction [over mangroves] more difficult to implement.

- Latin America offers few models for creating site-by-site management solutions.

The problem with Ecuador's mangrove management policy lies deeper than confusing regulations. The premise that mangroves should not be used, and that a centralized government agency can tightly control harmful activities, does not have any basis in Latin American or world experience. Countries that have relied on such policies—for example, the Philippines—have seen destruction exceed 50 percent. Puerto Rico lost 75 percent of its mangroves before proposing strict construction and zoning regulations.

During the period in the late 1980s when the PMRC was beginning to explore viable options to the failed policy of prohibiting mangrove cutting, two important developments were taking place in Asian countries that had a bearing on the future of Ecuadorian policy and implementation. First, in the early 1980s, the United Nations published a number of widely read reports on the status and traditional uses of mangrove management (Saenger, et. al, 1983; Hamilton and Snedaker, 1986; Vannucci, 1988). Second, the social forestry movement, along with training workshops and studies of successful traditional mangrove management practices in Asia and the Pacific, were influencing national policy and practice in some countries. The Philippines adopted sophisticated mangrove stewardship policies and programs to replace earlier unsuccessful centralized regulation (Kunstadter et. al, 1986; Department of Environment and Natural Resources, Philippines, 1991).

Unfortunately, Latin America has not benefited from the same level of international assistance in mangrove management. Although some regional activities took place in the late 1970s, Schaeffer-Novelli and Cintron (1982) point out that a lack of external funding has prevented regional coordination, resulting in a lack of research on Latin American mangrove forests. They go on to stress that management of mangroves for sustainable use must be determined on a site-by-site basis, accounting for the unique physical and social characteristics of each ecosystem. Ecuador, like every coastal tropical nation, must actively experiment to learn what will work.

#### **The emergence of the PMRC approach to mangrove management**

The PMRC defined its role in mangrove management through two early project efforts: the preparation of a shrimp mariculture strategy for Ecuador in 1986 (Olsen and Arriaga, 1989); and the issue profiles of the country's four coastal provinces. (Fundación Pedro Vicente Maldonado,

1987). Four of the six special area management zones (ZEMs—see page 149) that were included in Executive Decree 375 had substantial use conflicts over mangroves.

The mariculture strategy proposed two specific lines of work for the PMRC to follow. The first involved curtailing wetlands loss and protecting estuary water quality by focusing management on the mangrove ecosystem, not merely on forest cover. The mariculture strategy also urged the PMRC to show that better management could actually be done in Ecuador, including working with the shrimp industry to incorporate mangroves into their ponds:

An urgent planning priority is to develop demonstration plans for the management of mangroves. It is not feasible to expect that there will be no further destruction of mangroves. Realistic and implementable management strategies must be developed that can accommodate the continuing utilization of coastal resources.

Between Project Years 3 and 8 (1987–1993), about \$108,000 of U.S. Agency for International Development (USAID) funds were assigned to support a series of small demonstrations and other activities aimed at gaining knowledge and experience in managing mangroves for sustainable use.

The PMRC experiments confirmed that the largest untapped source of energy and resources for mangrove management remains the self-interest of mangrove users, and an enlightened citizenry that appreciates and acts to maintain the functioning of a critical coastal ecosystem. The initial tests of new mangrove policies by the PMRC show that it is indeed possible to tap into this source of local power with relatively inexpensive techniques and projects.

Public education in Atacames not only generated a strong demand for mangrove protection, it spawned local initiatives to include mangroves as a tourism and environmental education resource, and to clean up the Rio Atacames. It also empowered local residents to confront and resolve conflicts with shrimp farm operators. Mangrove protection has been a key focus of the three Ranger Corps (see page 223), who not only carried out patrols, but helped initiate dozens of enforcement actions and the formation of local watchdog groups. The Ranger Corps also helped in the preparation of user group agreements in which individual users committed themselves to carrying out mangrove conservation actions. Four ZEM plans adopted by the national government contain detailed findings, policies, and actions aimed at fostering sustainable use of mangrove ecosystems.

Since 1992, government institutions, researchers, academic institutions, nongovernmental (NGO) groups, communities, and user groups have worked together to examine the experiences of the PMRC and the results of small-scale projects, and have debated the design of new policies and strategies to remove the key obstacles to the rational administration of integrated management based on local participation. The final proposal developed in a national workshop held in 1993 at the Naval Oceanographic Institute, INOCAR, is found in Annex IV, and is now in the implementation stage. During 1995, the PMRC has worked with the National Forestry Institute to develop new regulations that include many of the ideas discussed in the mangrove workshop.

Although the best solutions to the national mangrove management crisis may lie predominantly in mobilizing the efforts of communities and resource users, the path toward fulfilling this vision of coastal management will require decisive national leadership. National agencies must still apply their legal authority and expertise to any new special area plans or user group agreements. National support for a management initiative in an estuary may be an essential precondition for obtaining financial assistance.

## PMRC STRATEGIES TO DEVELOP NEW APPROACHES FOR MANGROVE ECOSYSTEM MANAGEMENT

Prior to the initiation of the Ecuador PMRC, Snedaker et. al. (1986) examined the status of the mariculture industry in Ecuador and its impact on mangrove ecosystems. They found the mangroves to have a low diversity of species, low density, and reduced tree size. Heavy loss of man-



groves probably led to loss of artisanal fisheries, and may have had an impact on the shrimp larvae fishery itself. The authors presented data from Asia showing the link between greater mangrove habitat and shrimp production, and recommended a study of the Rio Chone to develop local information on these links. They also noted that, until very recently, mangroves in Latin America were considered to have little value, and that there was no experience in multiple-use management or forestry. Most timber harvesting was done on an extractive basis, and other countries were trying to follow Ecuador's example in developing a mariculture industry, rather than looking to the Asian example of sustained multiple-use management. The report also strongly urged Ecuador to move quickly to develop optimal use plans for the intertidal zone that considered all economic activities, and to carefully zone all mangrove areas to protect access for traditional uses. The authors urged the legalization of mariculture investments and concessions, which they proposed should pay for access to the resource, based on the potential productive value of coastal sites.

One of the first actions of the PMRC was the creation of a mangrove working group, an interinstitutional group dedicated to improving the knowledge base and management practices in mangrove ecosystems. It was composed of about 20 experts who worked in government, academia, and NGOs, and met informally to present information, debate issues, and design and carry out projects.

Mangrove management working group members:

Forest Districts of the provinces of Guayas, Esmeraldas, Manabí, and El Oro  
Center for Remote Sensing (CLIRSEN)  
Navy Merchant Marine (DIGMER)  
Subsecretary for Fisheries Resources  
National Fisheries Institute (INP)  
Natural Sciences Faculty of the University of Guayaquil  
Technical University "Vargas Torres" in Esmeraldas  
Technical University of Manabí  
Technical University of Machala  
Nongovernmental groups:  
Fundación Pedro Vicente Maldonado  
Fundación Natura-Guayaquil  
FUNDECOL, Muisne  
Fundación "Seeds of Life," Guayaquil  
FUNDEPRENA, Guayaquil  
CORPORENA, Guayaquil

In February 1987, Luis Arriaga and José Vásconez of the Environmental Directorate of Ecuador's Ministry of Energy and Mines (DIGEMA) presented the PMRC's first statement on the characteristics of a mangrove management strategy to Ecuador's first environmental congress. They proposed a program of work with several objectives: to evaluate mangrove ecosystems, including the nature of use conflicts and human impacts; to promote sustainable fisheries, forestry, and recreation uses; to build national capacity to manage multiple-use areas; to conduct education campaigns, training, and public outreach to build support for environmental protection; and to provide technical guidance, materials, and extension support for conservation efforts.

The following July, the PMRC's mangrove working group organized the first workshop to broaden knowledge and awareness of Ecuador's mangrove resources. The meeting, sponsored by DIGEMA, brought together national authorities, experts, and leaders of NGOs concerned about the rapid loss of mangrove resources.

The PMRC's Year 3 (1988) work plan launched work in mangrove management, which was based on five strategies:

- Bring international scientific expertise on mangrove ecosystems to Ecuador to exchange information and ideas with the mangrove working group.



- Build public awareness of mangrove issues, identify site-specific issues, and document mangrove ecosystem changes.
- Develop and test mangrove governance techniques.
- Test site-specific mangrove management methods.
- Prepare a national mangrove policy proposal.

The following sections examine in detail each of the strategies and resulting activities, and assess the results of these initiatives in terms of how the efforts helped further the PMRC's primary objective of creating a rich experience that would help justify a basic change in the approach to mangrove ecosystem governance.

### Strategy 1. Bring international scientific expertise to Ecuador.

Ecuador's scientists, public officials, and mangrove resource users were in the unique position of not only needing to learn more about mangrove ecology and stewardship, but being able to offer the international community a laboratory to conduct research and test ideas new to Latin America. The involvement of international researchers included training activities, visits and tours, and research projects.

#### Training activities

The PMRC sponsored a series of training activities through the mangrove working group, including workshops on mangroves for Guayas and El Oro provinces, and a study tour to Puerto Rico in 1989 by members of the working group. The tour involved experts based in Puerto Rico, such as Ariel Lugo and Gilberto Cintron, as well as Robert Twilley and the director of the Program of Ecology, Fisheries, and Oceanography of the Gulf of Mexico (EPOMEX); Alejandro Yanez-Arencibia. The mangrove working group organized three additional training events in Ecuador, addressing mangrove ecology (led by Twilley), fisheries (led by Arencibia), and forestry (led by Francis Putz of the University of Florida).

The flow of lessons was two-way during these events. Perhaps most notable is the reaction of Yanez-Arencibia (1991) of EPOMEX to his visit to Ecuador. He concluded that the declining profitability of the shrimp mariculture industry in Ecuador was caused by a squeeze between lower world prices and higher production costs, coupled with the degradation of mangrove ecosystems due to turbidity and erosion, organic enrichment of coastal waters, alterations in drainage patterns and circulation in estuaries, and increases in agrochemical residues. In his view, Ecuador now provided Latin America with the model of how *not* to develop shrimp mariculture. He was especially concerned that his home country of Mexico not repeat the series of mistakes in its coastal zone, and advocated experimentation with methods for achieving a sustainable mariculture activity.

#### Visits by international experts

Visits by international experts generated two funded scientific investigations, and stimulated the preparation of other research proposals—which in turn involved a number of students, professionals, and Ecuadorian researchers who have continued to be involved in the PMRC. The University of Rhode Island Coastal Resources Center (CRC)/USAID Coastal Resources Management Project (CRMP—see page 11) decided not to fund scientific investigations directly, but strongly supported the development of proposals that might be accepted by other donors.

#### Study of the mangrove reserve in Churute

The most important investigation related to the PMRC's efforts in mangroves was a comparative study on the importance of mangroves in sustaining fisheries and controlling water quality in coastal ecosystems. The study focused on the Churute Ecological Reserve, as well as on the Terminos Lagoon in Mexico. The project was proposed by Robert Twilley, Lucia Solorzano of Ecuador's National Fisheries Institute (INP), and Roger Zimmerman of the U.S. National Marine Fisheries Service (NMFS). The USAID Washington project officer for the PMRC, Nora Berwick,



along with Stephen Olsen, director of CRMP, worked to promote funding of the project by the USAID Office of the Science Advisor. The PMRC helped coordinate and provide logistical support to the field work.

The project focused on five aspects of the Churute ecosystem. The Office of the Science Advisor financed work carried out by INP on the nutrient cycle, and on the utilization of leaf litter. The latter was executed by NMFS and ESPOL. USAID Quito funded the Ministry of Agriculture National Forestry Directorate (DINAF) to support work on biomass production—carried out by the University of Guayaquil—and research on the effect of seasonal changes on the ecosystem. This was carried out by a DINAF staff member, Ramon Zambrano, who also was studying at the University of Leica Rocafuerte.

The resulting report (Twilley et al., 1993) documents destruction due to urbanization, wood production, and shrimp mariculture. It also notes natural stresses, such as damage from a bag worm that defoliated 1,000 ha in the Guayas estuary. The research also found that the production of leaf litter in the Ecological Reserve of Churute neither accumulates nor is exported, but is harvested and stored by the mangrove crab, giving the mangroves one of the highest reported litter turnover rates. Commercially valuable shrimp species *Penaeus vannamei* and *P. stylirostris* were found to be abundant in mangrove areas. Twilley cites the work of Turner (1989) in estimating that the loss of 25,000 ha of mangrove nationwide as of 1987 may have been accompanied by a drop in coastal zone shrimp production by 15,000 metric tons per year.

With greater river discharge and tidal exchange than other studied mangroves, the Churute Reserve system is a nutrient and sediment sink. Twilley notes the importance of site-specific characteristics in determining the role of a particular mangrove ecosystem, through comparisons of Churute with the highly altered Estero Salado, observing differences in salinity—a dominant characteristic that is determined by seasonal rainfall and river discharge patterns, and varies greatly along the coast of Ecuador—as well as in light, silicate concentrations, and use by estuarine fauna.

Twilley proposes that mariculture and other economic uses of the intertidal zone be integrated with the six ecological functions of mangrove systems, which fall under two broad categories: **Habitat quality** includes the functions of nursery, food source, and shoreline protection. **Water quality** includes the functions of sedimentation, nutrient sink, and pollution sink. The shrimp industry has caused many negative feedbacks to this ecosystem. Twilley prescribes using integrated pond management to take advantage of the habitat and water quality functions of mangroves—for example, by decreasing channelization of estuaries, filtering shrimp pond discharges, returning a portion of produced shrimp to the estuary to enhance wild stocks, reforesting mangrove estuaries, continuing seasonal freshwater discharges to the Rio Guayas estuary, and managing and protecting the mangrove crab fishery. He also calls for advancing work on valuation techniques for mangrove estuaries, which will in turn help focus additional mangrove research.

#### Guidance from other experts

In 1990, H. T. Odum, along with Betty Odum, Dan Campbell, and Stephen Olsen, conducted a field visit to key mariculture-dominated estuaries in Ecuador and offered lectures on the valuation of coastal ecosystems, applying his concept of emergy (solar energy value of resources). He raised a concern about the future health of mangrove ecosystems in Ecuador during periods of drought—building on Twilley's 1989 projections of the impact of changes to freshwater inputs of the Rio Guayas from the Daule-Peripe dam project. Without periodic pulses of fresh water, mangrove ecosystems will become degraded. Odum noted that the extensive mangroves of the Guayas estuary already exhibited signs of stress, and that some estuaries, such as the Rio Chone, had lost more than 90 percent of their mangrove cover, compared to a national average of about 14 percent. These site-specific impacts included displacement of people who had previously depended on mangrove fisheries and forest products, and loss of the fish habitat itself.

For the Rio Chone, Odum et al. (1991) recommended conservation of all remaining mangroves, along with a plan of reforestation along canals of shrimp ponds, and possibly on some emerging

islands. Freshwater inflow to the estuary also needs to be assured, the report stressed. This is threatened by the construction of the Esperanza dam project and irrigation for the central area of Manabí province. Carefully controlled tourism in wetlands areas could be a way of conserving mangroves while obtaining local economic benefits. Public education is essential and might include a research station that can support local investigations. The Odum report contains detailed recommendations for a research agenda, as well as measures for improving water circulation in the Rio Chone estuary.

Twilley and Costanza developed a proposal in 1991 to focus additional economic and ecological valuation work on the Rio Chone estuary. The proposal was not funded. Gonzalez (1993), with some assistance from CRC, developed a mathematical model of environmental factors affecting the shrimp mariculture industry, based on the Rio Chone estuary. Campbell and Agüero, along with Gonzalez, constructed an integrated model of the ecological and economic productivity of the Rio Chone, with some support from USAID Research and Development.

Two Asian experts in mariculture also conducted an extensive field visit to estuaries where mangroves had been replaced by shrimp ponds. Chua Thia-Eng of the International Center for Living Aquatic Resources Management (ICLARM) in the Philippines, and Pini Kungvankij, a shrimp expert from Thailand, examined the potential for improving the efficiency and diversification of the Ecuador mariculture industry. They concluded that existing shrimp ponds could be operated much more efficiently, that the current number of ponds was adequate, and that unused ponds should be replanted with mangroves. They estimated that as much as 27,000 ha could be returned to functioning mangrove ecosystem (see page 81–83 for more details of Odum and Chua recommendations).

None of the international experts offering guidance to Ecuador advocated pursuing the no-use policy adopted by the government of Ecuador, even though all were greatly concerned about the rapid degradation of mangrove ecosystems. They offered instead a variety of recommendations for the PMRC to test in order to achieve a realistic, effective approach to conserving the productivity of these systems. Most of these recommendations have subsequently been accepted as policies in special area management plans and tested in one of the ZEMs:

- Carry out public education programs.
- Promote ecological tourism in mangrove areas.
- Enforce existing conservation laws.
- Reforest shrimp farm intake and discharge canals.
- Actively experiment to develop sustainable mariculture in estuaries, integrating mangroves and productivity of mariculture.
- Zone mangrove areas according to appropriate uses.
- Restore mangrove area hydrology.
- Create buffer zones around shrimp ponds.
- Plant emerging islands with mangroves.
- Manage timber harvesting, and institute site-specific mangrove forest management.
- Protect freshwater inflow to mangrove estuaries.
- Prepare optimal use plans for all activities in the intertidal zone.
- Reforest abandoned shrimp farms.

#### Outcomes and assessment of scientific activities

The visits of scientists interested in mangrove ecosystems, and PMRC collaboration with research projects greatly stimulated learning and experimentation with mangrove ecosystem management in Ecuador. It also validated the idea that managing for sustainable use was a good path to follow in trying to keep the majority of the ecosystems productive. The PMRC directly benefited by hiring staff and consultants trained through their participation in research projects, including Alejandro Bodero, Mireya Pozo, Guillermo Garcia, Nikita Gaibor, and Ramon Zambrano. Two theses were produced in Ecuador (Zambrano, Guillermo Prado), along with those of Blanchard, Riveras, and Cardenas in the United States. In addition, several articles have been published or are in press in the international literature.



Many of the international investigators will continue to be tapped during the implementation of the Inter-American Development Bank project (see page 39), which will fully fund a number of the recommended management actions first suggested by scientists. This modest support for collaborative relationships between the international and local experts will continue to give good dividends, since it promotes long-term career commitments to advancing applied, as well as basic knowledge about Ecuador's mangrove systems.

The mangrove working group created a broad-based technical capacity that enables Ecuador to conduct new research and apply innovative management techniques. However, Ecuador has not generated its own mangrove ecosystem research program, nor has there emerged significant collaboration among the various universities of the coast to build capacity in mangrove forest management or ecological investigations. The PMRC focus has shifted to greater concern about specific problem areas in the ZEMs and about national policy. Over the past few years, the mangrove working group has become dispersed. Renewing its efforts must be a key priority of the PMRC under the Inter-American Development Bank project.

**Strategy 2. Build public awareness of mangrove issues, identify site-specific issues, and document mangrove ecosystem changes.**

Public awareness and education have unanimous support as a technique for changing attitudes and building support for mangrove management. The role of public education in mangrove ecosystem management is to promote awareness, understanding, and new attitudes among both adults and children regarding values and appropriate uses for these coastal resources. The audience for this message is diverse in its education levels and socio-economic status, as well as in the part individuals and groups play—consciously or unconsciously—in determining present and future mangrove condition and use patterns. Thus, a broad-based approach to education is required, since people must make decisions at many levels in order for new or strengthened mangrove management policies to take effect. At the national level, building general awareness and sensitivity, as well as a disposition to search for solutions at the highest political levels, can be accomplished through expanded television and print coverage of the condition and abuse of mangrove ecosystems, coupled with technical seminars, attention-raising events, and the use of mangroves as a theme in school curricula. At the local level, education efforts—such as talks by technical experts, oral histories of the role of a mangrove ecosystem in community life, school programs, mangrove tours, distribution of materials on local resources, small projects, and specific interventions in key decisions—can raise consciousness and prepare a community to give serious consideration to management proposals. This approach can bring together the groups who benefit from and who are damaging the mangroves, build participation in a planning process, and promote local vigilance and reporting of mangrove destruction.

The PMRC worked primarily with the Fundación Pedro Vicente Maldonado to carry out national and local-level awareness-building and educational activities—including work with the national press and local news media, programs aimed at ZEM residents, and programs and materials for the public education system (see page 179). At the same time, the PMRC collaborated with CLIRSEN to produce detailed inventories of mangrove forest cover change and shrimp pond construction, based on photography and satellite data. This is the primary documentation available on mangrove destruction coastwide, and is among the most complete and up-to-date information sources of its kind in Latin America. The results of these studies were published and distributed by the PMRC.

**Provincial profiles**

Mangrove issues received little press coverage and public attention at the onset of the CRC/USAID CRMP in 1986. After the shrimp mariculture workshop held in August of that year, the CRMP commissioned a set of issue profiles for the four coastal provinces. These were carried out by the Fundación Maldonado. The basic procedure involved the preparation of a draft document, followed by a provincial-level seminar in which local experts and leaders were asked to make presentations on coastal issues and to validate or correct the content of the document. Following publication of the profiles in 1987, the CRMP returned to discuss priority areas for management as part of designing the national coastal resources management program.

## CLIRSEN reports on mangrove loss

The most frequently cited information source on the changing condition and use patterns of mangrove forest is the work carried out by CLIRSEN, which mapped and measured shrimp pond, salt flat, and mangrove forest cover for all major shrimp mariculture areas, at a scale of 1:25,000, for the years 1969, 1984, 1987, and 1991. CLIRSEN perfected its ability to use Landsat satellite data in conjunction with aerial photography and field inspections to complete the inventory at relatively low cost. The summary results of the 1987 study were published and distributed by the PMRC through the Fundación Pedro Vicente Maldonado technical series in 1988, along with the Spanish translation of the report prepared by Snedaker et. al (1986) on the siting of shrimp mariculture ponds and management alternatives in Ecuador. CLIRSEN subsequently published a separate technical analysis of mangrove and shrimp pond types and summary maps of the distribution of ponds and mangroves by estuary. The PMRC again funded part of the preparation of an updated mangrove and shrimp farm map inventory using remote sensing images for 1991. The results were released in the PMRC's *Costas* newsletter.

In addition to documenting the status of mangrove forest, copies of the scale maps provided useful baseline data for mangrove law enforcement efforts of the PMRC, although site-specific conflicts usually require reference to individual farm concession maps, which were not prepared in reference to the CLIRSEN data. Ecuador still lacks accessible, comprehensive shrimp farm data that compares the area granted by concession to actual constructed ponds, and documents the impacts on specific mangrove forest areas. As noted earlier, CLIRSEN data does not give a complete picture of mangrove ecosystem loss, and field verification of mangrove forest condition for selected sites has just begun.

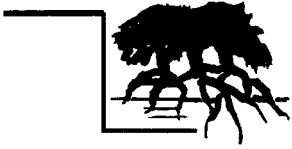
## Public education and outreach at the national level

Mangroves have been an important theme of the PMRC's outreach efforts. Two editions of a student workbook on mangrove ecosystems were prepared and distributed by the Fundación Maldonado during school years 1990-1991 and 1991-1992. The process included developing both the materials and teaching guide, working with technical consultants and the Ministry of Education, teacher training in the use of materials, and follow-up to evaluate use. Mangrove protection has also been a popular theme in many of the programs held during Environment Week in June—including contests in the arts on coastal themes; cleanup campaigns; parades; and talks on environmental subjects.

Mangrove issues have been featured in all of the outreach activities carried out for the PMRC by the Fundación Maldonado, including the *Costas* newsletter, which reaches 2,000 readers; media coverage; radio programs; a publication series that included a comic on mangrove conservation; and a 12-minute video produced for television and local events. The PMRC was able to build the press into an ally for improved management. One of the most extensively covered activities was the creation of the mangrove boardwalk in Atacames. In late 1993, extensive national press coverage on almost a daily basis focused on the construction of a shrimp farm near the mangroves of La Tola, where the largest remaining trees on the Pacific coast of the Americas are found.

## Public education and outreach at the local level

In addition to school programs, local education activities focused on furthering the ZEM planning process by building public interest and motivating participation directly. In the ZEMs, education efforts have often begun by reintroducing the historical importance of mangroves to community life, providing individuals who use mangroves with a group identity, and discovering ways in which intact mangroves can provide a local economic benefit. Guided trips to the mangroves have provided the first opportunity for both local residents and visitors to understand the social, economic, and ecological importance of the system. In Bahía de Caráquez, schoolchildren participated in a mangrove planting project on one of the emerging islands in the estuary. During the ZEM planning process, public education created a context within which shrimp farm operators or municipal decision-makers whose actions result in further mangrove loss can be confronted and convinced to halt their destructive actions. In cases such as the Estero El Morro, in the Playas



ZEM, public education has been used to begin a process that includes training, small projects, and the establishment of user group agreements to implement protection measures. (See Annex V for the text of the Atacames user group agreement.)

#### Outcomes and assessment of information and public education activities

Education efforts by the PMRC, the Fundación Maldonado, and many other Ecuadorian NGOs have expanded national press coverage of mangrove issues. The most recent example for the PMRC was the 1993 national mangrove symposium (see Strategy 5), which was followed by extensive press coverage.

The PMRC has demonstrated that local groups can play an important role in generating enthusiasm and support. However, in the long run there must be a permanent presence who can distribute general information, generate local educational materials and learning experiences, and reach all of the different audiences who ultimately will determine whether mangrove management succeeds. Once general awareness is built, follow-up is necessary to focus on the issues and concerns of specific locations. This in turn may lead to the formation of local groups who not only require knowledge on which actions and decisions are best for the ecosystem, but on how to continue functioning as a resource user group.

Perhaps the group least effectively reached and influenced by education and outreach efforts is the shrimp mariculture industry. The PMRC needs to examine its outreach approach to develop effective ways for informing and persuading this major coastal resource user group to participate actively in resource management efforts and to contribute to workable mangrove ecosystem management solutions.

The inability of the CRC/USAID CRMP to provide more funds for a consistent effort in documentation and outreach during Project Years 8 and 9 has been a source of frustration to staff and communities. This situation is expected to be corrected in part by the Inter-American Development Bank project. More timely and frequent production of the CLIRSEN mangrove inventory, and linkage of this data to other sources of information—such as shrimp farm concessions—are technically straightforward, and would boost efforts in enforcement by the Ranger Corps, and aid community-based stewardship through local groups. Modest funding for school materials, field trips, and small projects would have an immediate effect not only on science and environmental education in the coast, but on the attitudes of an entire generation of coastal resource users.

#### **Strategy 3. Develop and test mangrove governance techniques.**

At the shrimp mariculture workshop in 1986, Pérez and Robadue (1989) observed:

The use of coarse tools—such as prohibitions on all mangrove disturbances—that are difficult and costly to enforce must be replaced by area-specific mangrove management programs that can enlist the support and involvement of all those who depend directly and indirectly on the productivity of mangroves for their livelihoods.

The PMRC has experimented with innovative approaches to mangrove management in two distinct ways. Through the Ranger Corps, mangrove management projects were initiated by identifying traditional users and helping to organize them to participate in the ZEM planning process. The local ZEM committees unite authorities, resource users, and community members to discuss and approve the design and implementation mechanisms of site-specific management regimes.

The policies and actions in the ZEMs are summarized below. Variations in policies among the zones reflect differences in local environmental conditions, the presence or absence of organized groups to carry out specific actions, and the relative priority of mangrove management compared to other coastal issues.

### Bahía de Caráquez-San Vicente-Canoa

Mangrove loss has been most dramatic (greater than 80 percent) in this ZEM, with episodes of cutting still taking place along the few remaining forested islands. The one remaining large (100-ha) stand at Buena Fe has been protected by local authorities, after some cutting for illegal shrimp pond construction. The Rio Chone estuary has been targeted by all scientific advisors as a key location for experiments in restoration, replanting, ecosystem-based management, freshwater inflow protection, ecotourism, and shrimp mariculture. Small groups of shellfishers have emerged who are interested in experimenting with shellfish bed management and aquaculture.

Examples of policies and actions in the ZEM plan:

- Prevent any additional destruction of mangroves, and manage existing areas for sustainable multiple uses. [Bahía de Caráquez 3.2.1]
- Protect important ecological areas in the Rio Chone estuary. [Bahía de Caráquez 3.4.1]
- Promote the forestation of sediment-accumulating areas, emerging islands, and shrimp farm discharge canals. [Bahía de Caráquez 4.5.1]

In this ZEM, a user group agreement was signed that focused on the mangrove resources of the Rio Chone, and several practical exercises (see page 201) were carried out to test the potential of reforestation.

### Playas-Posorja-Puerto El Morro

The small, heavily utilized Estero Data de Posorja, which runs behind the 11-km tourist-oriented barrier beach between General Villamil (Playas) and Data de Villamil, has been subjected to hydrologic modifications by shrimp mariculture. The Estero de El Morro, on the eastern border of the ZEM, is at the edge of the large mangrove shrimp pond-dominated Guayas estuary. Although fishing for mangrove crab and other species is an important activity, the location of these areas on the periphery of ZEM settlements, away from existing tourist facilities, along with the dominance of tourism beach use conflicts, has given mangrove management and formation of user groups a lower priority in the ZEM plan and program activities.

Example of policies and actions in the ZEM plan:

- All mangrove forest in the ZEM will be protected or conserved with the objective of maintaining and improving their role in coastal ecosystems, as habitat of marine and upland organisms, and for renewable energy and tourism. [Playas 3.1.5]

A user group agreement was established in the Estero de El Morro that focused on the mangrove ecosystem.

### Machala-Puerto Bolívar-Isla Jambelí

This ZEM is set in the coastal urban area of Machala-Puerto Bolívar, at the northeastern edge of a very large mangrove shrimp pond system along Estero Santa Rosa, which dominates the entire coast of El Oro province. The rate of mangrove cutting in the region as a whole has subsided since the early days of the shrimp mariculture boom, which began in this area. However, the ZEM is faced with every form of mangrove destruction, from urban expansion of Machala and Puerto Bolívar, to expansion of shrimp ponds, to effects of artisanal *precriaderos* (shrimp larvae fishermen) and wood harvesting. At the same time, nearby fringe mangrove and small mangrove islands remain intact, maintaining a surprisingly attractive passage for visitors to the island of Jambelí. There are thousands of artisanal fishermen who depend on the mangrove ecosystem, community groups have shown an interest in managing small mangrove ecosystems, and mangrove law enforcement has been an important theme of the work of the Ranger Corps.

Examples of policies and actions in the ZEM plan:



- The use of mangrove areas for multiple values—including scenery, shellfishing, wood harvesting, and education—will assure conservation of mangrove resources and sustainable forms of use. [Machala 3.4.1]
- Mangroves should be zoned to establish appropriate uses based on the characteristics of individual areas and local use needs, as the basis for a system to control mangrove cutting. [Machala 3.4.3]
- Public awareness and education programs must be developed in order to teach user groups and local communities basic mangrove management concepts. [Machala 3.4.4]
- Deforested mangrove areas should be replanted, along with discharge canals of shrimp ponds. [Machala 3.4.2]

Specific projects to conserve mangroves include: restoration of mangroves in the Estero Huayla, which is located along the waterfronts of Puerto Bolívar and Machala; management of the use of mangroves on the Isla de Jambelí; zoning of remaining mangrove forests; and an intensive public education campaign.

#### Atacames-Súa-Muisne

The remaining mangrove forests in the Atacames-Súa-Muisne ZEM are located near the two largest villages, Atacames and Muisne. The Rio Atacames had lost about 90 percent of its mangrove cover by the early 1980s due to legal shrimp pond construction. The rapid encroachment of illegal shrimp farms in Rio Muisne was underway as the ZEM program began in 1989. The ongoing conflicts generated by pond construction and urbanization demonstrated the need for action and also provided numerous opportunities for active intervention.

Thus, mangrove management emerged early on as an integrating issue in the Atacames-Súa-Muisne ZEM, and served as the testing ground for ideas in public education, conservation and enforcement, mangrove replanting, conflict resolution, and mangrove zoning. These were incorporated into the ZEM plan, as well as put into action through some formal PMRC projects and local initiatives.

The policy statements that govern mangrove ecosystem actions within the ZEMs are aimed at promoting sustainable use, but within the context of conserving all remaining mangroves, since all of these zones have suffered losses much greater than average.

Examples of policies and actions in the ZEM plan:

- All mangrove forest in the ZEM will be protected or conserved, with the objective of maintaining and improving its role in coastal ecosystems, as habitat of marine and upland organisms, and for renewable energy and tourism. [Atacames 3.1.2]
- The boundaries of shrimp ponds must be precisely fixed, with no future expansion permitted. Buffer strips should be established around the borders of shrimp ponds, including areas that can be managed for shrimp capture, and fish and shellfish cultivation. [Atacames 3.5.2]

The policy of limiting the borders of shrimp farms was adapted recently to the conflicts over new pond development outside the ZEM in northern Esmeraldas. An agreement between the community of Olmedo and the Purocongo company was prepared to protect the important mangroves of Majahual. The agreement among the shrimp farmer, community, and authorities was to maintain a 50-m setback from the shrimp farms and the mangrove stand, a boundary that continues to be respected.

The PMRC concentrated its tests of mangrove management techniques in the Atacames ZEM,



under the leadership of ZEM coordinator Rómulo Jurado and PMRC forester Alejandro Bodero. The initial focus was on the fate of the 52 ha of mangroves remaining in the Rio Atacames. The preparation of a community profile and mangrove management report provided the opportunity for community discussions and awareness building, working with local schools and mangrove users. The process involved presentations and field trips into the mangrove area. The fringe and remaining uncut mangrove forest were very close to the village center of Atacames, which has been constricted in its growth by the conversion of fields and mangrove to shrimp ponds.

The awareness building among members of the ZEM advisory committee, which represented all coastal communities and user groups, provided a vital forum for working with the village of Atacames. This was then followed by the emergence of mangrove user groups, and eventual involvement of the mariculturists responsible for the recent, rapid loss of mangroves and fishery access. This step-by-step approach has been applied to develop a constituency for mangrove management in the three other ZEMs, each of which has unique needs and conditions.

Table 1 summarizes how the local issues found in the Atacames-Súa-Muisne ZEM have been used to gain experience in most dimensions of managing mangroves for traditional uses and conservation. This set of activities was not mapped out in detail in advance, but emerged through the PMRC's annual work plan process and monthly ZEM committee meetings. Yet, in retrospect, the work appears to take the shape of a comprehensive approach to the mangrove issues of the ZEM.

Atacames ZEM test	Strategy	Actions	Results
<b>Education and awareness program</b> 1989-1993	Introduce new information and materials. Make link to existing, past, potential uses.	Expert presentations, site visits, school programs, community discussions, simple education materials.	Increased sensitivity to mangrove values and consensus on need for conservation, awareness of management techniques.
<b>Sendero de la Casa Verde and boardwalk in Atacames</b> 1990-1993	Create facility for direct education of local children and adults. Create tourism attraction that can add economic incentive for mangrove protection.	Construction of initial boardwalk in Rio Atacames; distribution of interpretive brochure; reconstruction of boardwalk (approved by national coastal commission in 1991); organization and support to guide group operating tours and walks; training of guides and materials development; solicitation of large amount of additional funds for project completion.	Successful, but first boardwalk deteriorated rapidly. Reconstruction was more expensive and slow. Access to site resulted in illegal cutting. Initial leadership lost when ZEM committee assigned responsibility to newly formed group of young guides. Full operation of tours found to be more complex, requiring business development skills. Full-scale project to be funded by Inter-American Development Bank.
<b>Ranger Corps and community vigilance of mangrove areas</b> 1991-1993	Unite port captain and agency field officers for more frequent, collaborative enforcement. Work with local residents for notification of violations.	Funding (in 1991) to provide an assistant to Esmeraldas Ranger Corps, with focus on Atacames and Muisne issues.	<u>Joint patrols</u> under leadership of Esmeraldas port captain. <u>Organization</u> of local residents. <u>Participation</u> of member agencies in ZEM planning process, with initiation of parallel projects. Identification of <u>legal status</u> of shrimp ponds. Participation in <u>conflict resolution</u> meetings.

Table 1. Analysis of mangrove management actions carried out in Atacames-Súa-Muisne.



Atacames ZEM test	Strategy	Actions	Results
<p>Reforest shrimp canals in Rio Atacames</p> <p>1991</p>	<p>Develop collaborative relationship with shrimp farmers to foster participation in ZEM process.</p>	<p>Planting of 10 ha of mangroves along canals and pond walls, especially near boardwalk.</p>	<p><u>Successful planting</u> and growth. <u>Complete loss</u> of mangrove fringe, due to pond owners removing sediment from ponds and reinforcing pond walls, killing young trees. <u>Relocation</u> of planting efforts to Rio Muisne.</p>
<p>Involving the shrimp mariculture sector in Muisne</p> <p>1992-1993</p>	<p>Ranger Corps action against the large number of illegal shrimp ponds (about 80 percent), nonpayment of fees. Collaboration of pond operators with community-based management efforts.</p>	<p>Survey of legal status of ponds. Invitation of pond operators to ZEM planning meetings. Intervention to resolve site-specific conflicts with pond operators.</p>	<p>Extended period of <u>non-participation</u> by pond operators. Actions taken by port captain against some illegal facilities. <u>Conflicts</u> between individuals and local groups and some pond operators. Few signed user group agreement on mangroves. <u>Legal actions</u> initiated on more than 70 violations. Growing number of pond operators <u>participate in roundtables</u> on the PMRC in 1993.</p>
<p>User group agreement on mangrove management</p> <p>1992</p>	<p>Obtain personal local commitment by authorities and resource users on conservation of allocation of public access.</p>	<p>Preparation of a document stating principles of conservation, commitment to design, and protection of common use areas. Investigation of shellfish mariculture with <i>concheras</i> (cockle fishers in Bunche.</p>	<p><u>Adoption of user group agreement</u> by authorities, user groups, PMRC. Illegal shrimp pond owners did not participate at first. <u>Follow-up activities</u>, local group organization, and initiatives. Action on <u>research projects</u> to test different techniques for supplementing incomes of collectors of mangrove cockles.</p>
<p>Resolving site conflicts: Comedores "El Manglar" in Rio Atacames</p> <p>1991-1992</p>	<p>Use pending decision of municipality of Atacames to introduce better site planning and decision-making.</p>	<p>PMRC-funded development of alternative design for food vendors who wanted to fill Rio Atacames mangroves near foot bridge to tourist beach. PMRC and the Ranger Corps opposed local decision to approve house construction in site.</p>	<p><u>Agreement</u> between municipality and food vendors to modify proposal for filling, although vendors demanded financial assistance for project development. Included <u>project funding</u> in Inter-American Development Bank project. Link to overall mangrove tourism proposal. PMRC site monitoring has prevented encroachment.</p>

Table 1, continued.

Atacames ZEM test	Strategy	Actions	Results
<b>Shrimp farm canal controversy, Rio Atacames</b>  1992-1993	To enforce existing mangrove agreements.	Intervention of Ranger Corps and PMRC ZEM office to prevent construction of new water intake canal by shrimp farmer in Rio Atacames. Proposal developed by PMRC to link need for controls of water pollution and solid waste in estuary, and to improve management of the shrimp ponds.	<u>High-level involvement</u> of Merchant Marine and Forestry Agency in developing resolution. Agreement by shrimp farmer to <u>desist construction</u> of new canal and cutting of mangroves. <u>Analysis</u> provided by PMRC of water quality issues faced by farmer.
<b>Buffer zones around shrimp pond, Rio Atacames</b>	Control of application of pesticides to agricultural land in small watershed affecting pond.		Shrimp pond owner in Rio Atacames reported to have purchased site of proposed banana plantation to avoid application of toxic chemicals near ponds and in microwatershed.
<b>Replanting of mangroves, and forest management, Rio Muisne</b>  1991	Rehabilitate degraded areas and demonstrate potential for local forestry management.	Planting of propagules in degraded forest area in several sites within Rio Muisne, using local participation. Development of monitoring techniques to evaluate results. Pretest of larger (200-ha) proposal included in Inter-American Development Bank project.	<u>Good growth</u> of replanted areas. Problems with mangrove crabs and with harvesting young plants, finding good source of propagules.

#### Outcomes and assessment of mangrove governance techniques

The PMRC has successfully tested local acceptability and the overall feasibility of initiating several innovative approaches to mangrove management. Funding is now in place from the Inter-American Development Bank to implement a number of actions adopted by the ZEMs and to expand the operations of the Ranger Corps. The concentration of effort over the past several years on two small sites in the Atacames ZEM revealed a great deal about implementation problems, and enabled the ZEM staff and PMRC technical experts to follow the evolution of community participation and small project implementation through complete cycles of design, execution, evaluation, and redesign.

The adaptive approach, as formulated by Jurado and Bodero (see next page), suggests that there are preconditions to be met before a community is prepared to take on greater responsibility for mangrove stewardship. It seems that the PMRC or similar organization must play a continuing role in guiding, advising, and assessing the process and outcomes of each action. Other ZEMs have been anxious to begin implementing mangrove stewardship actions, but even within this supportive context, PMRC staff have wisely adopted a cautious approach to launching new initiatives.

As part of its continuing experimentation, the Ecuador PMRC should test just how necessary the ZEM planning framework is for generating local interest, support, adoption, and successful implementation of stewardship for sustainable use. If a simpler program of activities could be formulated, accompanied by sufficient technical support to follow the entire cycle of action outlined by Jurado and Bodero, the PMRC could make a more rapid, substantial contribution to reversing current mangrove destruction trends and to ushering in an era of stability for the ecosystems and the people who depend on them.



Jurado and Boderó used the ZEM plan preparation process, special mangrove projects, the practical exercises task of the ZEM committee, local decision-making events, and the daily operations of the ZEM office and ZEM committee to both initiate and provide follow-up to mangrove projects and conflict resolution. Guillermo Prado, a forester and student at the University of Esmeraldas, provided technical support and supervision to local planting efforts, site analysis, education, and monitoring tasks. Carlos Hernández, the PMRC's Ranger Corps assistant, organized patrols and responses to individual cases. The PMRC's mariculture working group, led by Segundo Coello, carried out long-term applied investigations and technical assistance in both the mangrove shellfisheries and site-specific conflict resolution. The continuing presence of technical expertise, program support, and ZEM committee oversight is a key factor in the ability of the ZEM to address the wide range of techniques involved in these mangrove management tests. The process can be summarized as follows:

#### ***Adaptive approach to mangrove management***

##### **Introduce theme to area and build constituency.**

- Create awareness and provide education at the community, school, and user level on a continuous basis.
- Facilitate the forming of informal mangrove user groups with common interests, located within a specific mangrove ecosystem, in order to create forums to discuss common concerns.
- Strengthen user group organizations to serve as the basis for implementing mangrove stewardship projects.

##### **Initiate practical actions.**

- Work on specific tasks, such as small demonstration projects and action research on forest and shellfish management, providing technical assistance and funding.

##### **Initiate planning process.**

- Broaden involvement of user groups in overall ZEM planning process to create consensus on issues, goals, and objectives for mangrove management; expand the number of stakeholders in good mangrove management, including those involved in new economic uses.

##### **Implement mangrove ecosystem management plans.**

- Prepare agreements and resolutions that link user groups and authorities.
- Use case examples to implement, and therefore reinforce the importance of the agreements.
- Elevate the importance of implementing ZEM plan policies to local and regional authorities.
- Pursue opportunities to gain private sector collaboration, especially from shrimp farmers.
- Maintain oversight of mangrove management efforts in the ZEM committee.

One effect of the progressive, adaptive approach to mangrove management in Atacames and Muisne has been the increasing local insistence on implementation of projects, and continual requests for PMRC ZEM office involvement in resource management conflicts. This shifts the arena of action from generating demand—a critical early phase of any development initiative—to providing the services and continuous follow-up needed to keep the local management process going.

### Enforcement of mangrove laws

The basic mangrove management policy and law in Ecuador continues to require the protection of all mangroves. Although the experience of the PMRC has led to the conclusion that controlled use and selective cutting should be permitted, a formal system for allowing this is not yet in place. In most estuaries of the coast—including mangrove reserves and the four ZEMs that have adopted policies calling for protection of all remaining mangrove stands—enforcement of this law remains necessary. Any agreements to permit controlled cutting or other alterations also require supervision and enforcement. A coercive approach to mangrove law enforcement is required by existing laws, yet Ecuador does not have the funding, political will, or administrative or staff capacity to inform all potential violators of the rules, to conduct regular patrols, or to follow up on violations with adequate punishment to deter other violators.

When a majority of community members supports an environmental law, these community members may also collaborate with authorities by assuring that violations are noticed and receive some form of sanction—by notifying authorities of a suspected violation, and by following up on the actions taken to resolve individual cases. This concept has been extended in Ecuador through the creation of the Ranger Corps, who attempt to make better use of existing and scarce enforcement resources through an assistant who works with the local port captain, and by using community monitors—community members who live and work near a particular mangrove ecosystem and can quickly detect violations.

In Bahía de Caráquez, the Ranger Corps has played a major role in mangrove protection. Their efforts have led to the offering of mangrove and estuary island tours by private guides in the Rio Chone estuary, and to a small planting effort by students. Some shrimp farmers have replanted canals and maintain a buffer around their ponds. Conflict resolution over shrimp ponds and mangroves is still needed. Work was initiated in 1993 with small communities interested in managing and restoring shellfish resources in mangrove areas.

Some 40 legal actions against mangrove law violators have been initiated, especially through the Puerto Bolívar captaincy, which covers El Oro province. A key difficulty is the lack of sufficient resources to follow these actions through the legal system. The Ranger Corps has also participated in the drafting of user group agreements, which are an additional step toward instituting voluntary compliance, as well as toward defining more clearly which portions of a mangrove forest or fringe should be utilized for a particular purpose—such as reforestation, fishing, selective cutting, and conservation.

In Machala-Puerto Bolívar, initial enforcement efforts led by the Ranger Corps must confront a mangrove shrimp pond ecosystem many times larger than in Atacames or Rio Chone. The national forestry agency has recently issued concessions to a community to manage a 300-ha area of mangroves for conservation and traditional uses, with the PMRC providing some technical assistance in designing a management plan.

### Long-term implementation prospects

Full-scale implementation of the mangrove management policies and actions in the Atacames and Muisne areas is planned under the Inter-American Development Bank project, with projects in the other three ZEMs to follow later, based on the initial experience gained in these two sites. The following projects will be funded:

- Mangrove boardwalk, Atacames;
- Protection and reforestation of Muisne estuary mangroves;
- Mangrove tour facilities, Rio Chone;
- Protection and reforestation of Rio Chone estuary mangroves;
- Mangrove tour facilities, Puerto El Morro;



- Protection and reforestation of El Morro estuary mangroves;
- Mangrove tour facilities, Jambelí; and
- Protection and reforestation of Isla Jambelí mangroves.

#### Strategy 4. Test site-specific mangrove management methods.

Community groups can be educated and persuaded to take on a stewardship role. Special area management programs can provide all the social and managerial support necessary to keep mangrove users productively engaged in experiments and implementation. But will the actions proposed by scientists, mangrove users, and technical experts lead to sustainable use? Are they practical?

The PMRC carried out several small projects to explore this question. In the process, the definition of what each action entails has become much clearer, along with the requirements for successful execution and criteria for evaluating success. Perhaps the most important discovery is that actions that on the surface seem primarily local in nature often have a hidden requirement for national approval or specialized technical assistance. This section examines tests of ecotourism, harvest management, forestation, and multiple-use zoning.

##### Ecotourism in mangroves

Mangrove ecosystems in Ecuador contain an abundance of flora and fauna and provide a natural, permanent greenway along many coastal areas. Guided tours, scientific research, and carefully built public facilities such as boardwalks and interpretive paths can provide a unique opportunity to expand tourist offerings along the mainland coast, both to residents and to international visitors. This in turn creates an economic incentive for mangrove protection. The role of the public sector versus private enterprise in leading facility and service development remains a key question.

The Churute Mangrove Reserve in Guayas province is the only example in Ecuador of a government-operated reserve. To succeed, it requires continuous control over public access, strict limits on physical changes to the reserve, active research and monitoring programs, environmental interpretation, fisheries management, and mitigation of the environmental impacts of development of adjacent areas. The success of the Churute Reserve is due to the long-term commitment of INEFAN and other agencies, as well as NGOs such as Fundación Natura to provide adequate financial and personnel resources. The PMRC also made a contribution in helping support studies of the reserve.

Initial experiments in mangrove tourism and related facilities in Atacames, Bahía de Caráquez, and Puerto Bolívar show the need to involve private sector and local groups in providing services and resource protection, as part of a coordinated, but not necessarily publicly managed effort. The "Sendero de la Casa Verde" for the Rio Atacames encountered many operational problems as it grew in concept from a simple boardwalk to an addition to the tourism offerings of the popular Atacames beach (see Table 1). It required numerous support services, including reconstruction of the walk; river cleanup; organization and training of guides; interpretation; pricing and marketing of tours; protection of sites designated for a pier for tour boats; proper design of a facility for food, crafts, and folklore exhibitions; and management of activities.

A similar idea was developed in the Puerto Bolívar-Machala-Isla Jambelí ZEM as a practical exercise. Tourism is already well-established in Isla Jambelí. Visitors must take a small boat to reach the island, passing through a fringe of mangroves, as well as through evidence of shrimp pond operations and mangrove destruction. A boardwalk was built on the Isla de Amor, and visitors were brought to the site from Puerto Bolívar.

In the Rio Chone, local boat operators began to take visitors to mangrove islands such as Isla de Fragatas. Too many tours by untrained guides threatened to disrupt the bird nesting areas, so the ZEM office organized training, and the port captain now requires a permit for tour boats to enter the site.

### Research and mangrove harvesting

One of the traditional uses of Ecuador's mangroves has been as a source of wood for pilings, poles, charcoal, and lumber. In the initial formulation of the PMRC's work in mangrove management, tests of harvest management and sustainable forestry practices were to be carried out in most of the coastal provinces. Funding limitations led to focusing this effort on a site in Esmeraldas province, in which 10 plots, 30 by 120 m, were clearcut of *Rhizophera* to observe natural regeneration as a sustainable forestry practice. The work was carried out in conjunction with the University of Esmeraldas and involved Guillermo Prado (1983), who has provided extensive assistance to PMRC projects in Atacames and Muisne. Blanchard (1993) reports on the results of this experiment, noting that the sites were very different in terms of elevation, tidal inflow, and in the number of large, propagule-bearing trees at the edge of clearcut sites. He also found large differences among the 10 plots in terms of density and size of seedlings, which were most abundant at the edges of the plots. The factor most important to plot regeneration was the presence of larger diameter trees on the edge of the cut plots. He recommended that clearcuts not extend to the water, and that they be reduced to 20 m, to increase the likelihood of regeneration.

In poor sites, it will also be necessary to leave high-quality seed-producing trees in the middle of the plot. In reviewing the results of the experimental cutting and regeneration study in Esmeraldas (Isla Tatabrera), Putz (1992) concludes that the 30-m-wide clear strips are too wide if natural regeneration is the only management technique employed. He recommends narrower cuts, leaving seed trees within clear-cuts, and continuous experiments with different cutting techniques in different mangrove environments. He strongly advocates identifying an applied researcher/advisor who can provide hands-on guidance to the ongoing work, follow up on the hypotheses that the Tatabrera experience suggests, and prepare publishable articles that will make a contribution to the world literature.

Putz observes that the clearcut method might be a reasonable approach if modified to address site-specific conditions and increase the chances of natural regeneration, since signs of advanced regeneration in the forest are not much in evidence before logging, and completely gone afterward. He proposes a set of hypotheses that should be tested as part of introducing mangrove forestry practices to Esmeraldas:

- Recruitment density in clearcut strips decreases with increasing distance from the edges of the retained forest; is concentrated around retained trees within clearcuts; varies with plot elevation; varies with elevation within sample plots; and decreases with increasing cover by *Acrostichum* ferns.
- Seedlings are concentrated where propagule movement is impeded by logging debris or other factors interfering with their movement by water.
- Propagule production by trees bordering clearcuts differs from production by trees in closed forests, and increases with tree size.
- Tree mortality rates are higher on clearcut edges than in the forest interior.

Putz observes that understanding the factors leading to the most successful natural regeneration is important for an effective forestry management approach based on controlled commercial harvest. However, social conditions might permit active management methods such as replanting by local groups or concession holders who have a long-term interest in the mangrove stand. "People are more likely to protect a stand that they planted than one that regenerated naturally," he points out. Putz notes that the PMRC needs to make its support of this approach more explicit.

### Forestation

The PMRC has only begun to develop an understanding of how mangrove restoration and reforestation should involve private or community groups. An experiment with reforestation of the shrimp farm canals in Atacames was unsuccessful due to a lack of cooperation by shrimp pond owners. Ten hectares were planted with help from the PMRC, with good growth. However, shrimp farm owners excavated portions of ponds and dumped the dredged material on the young mangrove trees, which could not survive the physical destruction. There has been some coopera-



tion in Rio Chone on mangrove forestation along some ponds, but this has not become a widespread practice. An opportunity for working with shrimp pond owners may occur during the renewal of shrimp pond concessions over the next five years.

After the problems in Atacames, a successful test of planting in degraded areas was carried out in Muisne. Ten hectares have been growing well for two years. As a result, additional funding for mangrove planting will be provided by the Inter-American Development Bank.

#### Mangrove use zoning and the need for national policy reform

The establishment of clearly demarcated geographic zones with specific permissible and non-permitted uses, and performance standards for any allowable use is a fundamental tool of land use management. This tool has increasingly been applied to coastal resources as well. Predetermination of allowable uses is often difficult and time-consuming at the outset—the scientific and planning work to determine acceptable uses and to build a sufficient political consensus for adoption can be controversial. However, in the longer term, zoning usually makes administration and enforcement of permit decisions easier, assuming there is a technically competent, fair, and properly administered decision-making procedure.

A complete zoning proposal should include

- A specific list of allowable and non-allowable uses;
- Precise designations of the water, shore, and land areas covered by the zone;
- A regulatory procedure for issuing and enforcing permits;
- Sanctions for violating the terms of the permit, as well as of the zone; and
- Policies and procedures for giving variances to the zone or to nonconforming uses.

In practice, the term "zoning" is often used to signify many different kinds of mangrove management policies that are more complicated than a simple ban on all cutting. Zoning schemes can be adopted by a municipality, or regulatory or planning agency, that has the authority to make and enforce decisions. A planning document or informal mechanism such as a user group agreement may include strong indications of how specific areas should be used, but cannot be considered zoning, since it lacks direct enforceability.

The ZEMs have just begun to provide very early experiences on how zoning strategies could be used through user group agreements, municipal ordinances, and concessions granted to communities or individuals by INEFAN, the Navy DIGMER, and the Subsecretary of Fisheries. Virtually all coastal municipalities lack an overall land management plan, and make decisions on mangrove filling or destruction case by case, with little or no technical input. The municipality of Atacames has only recently modified its approach to controlling the use of mangrove areas, as a result of strong PMRC involvement. In Rio Muisne, areas have been assigned uses by the user group agreement, and the need for clear markings of specific boundaries is fully recognized. However, the presence of a large number of illegally constructed shrimp ponds in the Rio Muisne makes it very difficult to set specific, enforceable boundaries for use zones, and questions of enforceability must still be answered. Despite these difficulties, it may be easier to develop site-specific use plans and zones in areas where controversies exist than it is to prepare a larger-scale zoning ordinance for a 10,000- or 20,000-ha mangrove ecosystem.

The PMRC's activities have led to a uniquely Ecuadorian innovation. Through the user group agreement, mangrove user groups have found it possible to create locally based written agreements for ZEM plan or site implementation, or for specific remedies. The agreements are signed by shrimp farmers and different mangrove users, as well as by public officials. Although these do not have a legally enforceable status, they serve to reinforce one of the most important characteristics of a realistic policy—a social consensus to support management initiatives. As of 1994, agreements have been reached in Atacames-Súa-Muisne (Annex V), Estero de el Morro, and Bahía de Caráquez. Common elements of the agreements include a preamble stating the conditions and issues of the ecosystem; an acknowledgment of the ZEM plan findings and policies; mention of desired uses and conditions of specific areas; a list of actions that specific groups agree to undertake, such as



assigning an agreed-upon use, or participation in enforcement patrols; and the signatures of a diverse group of organizational leaders and individuals directly involved in activities in the sites. The process for arriving at these agreements typically begins with an awareness campaign and with the involvement of the ZEM committee in a specific use conflict or controversy. Local staff and technical advisors work with individual groups and then set up meetings of all key people from the area to work out points of understanding and specific actions. When details of management actions are determined, the ZEM committee should review them and consider including them in the ZEM plan.

#### Outcomes and assessment of site-specific mangrove management tests

The repertoire of practical measures to conserve and allocate uses of mangroves is expanding as a result of experimentation by the PMRC, INEFAN, and NGOs. These tests reveal the real-life complications that ensue from seemingly simple ideas, such as planting a few hectares of mangroves, attempting to put some order into how mangroves are harvested for timber, or creating a mangrove use allocation scheme that can satisfy user needs and resolve conflicts as they occur. In each case, it is vital to provide timely technical assistance and adequate resources to carry a project through. The natural mangrove forest regeneration study, for example, provides good insights into the skill needed to carry out even a simple scheme. Ecuador must build its expertise in assessing appropriate regeneration practices, based on continued experimentation to test the hypotheses proposed by Putz, rather than adopt a single forest management rule and attempt to enforce it. Even trying to manage forest areas without requiring complicated reforestation or selective harvesting techniques is going to require competent administration.

PMRC experience shows that even the simplest schemes for controlling mangrove wood production involve identifying specific plots to be clear-cut, preparing and issuing a license based on studies of local conditions and recommended harvesting practices, and follow-up enforcement. More complexity can be introduced by issuing long-term management concessions that require rotated cutting within the concession, or by using stewardship agreements that call for selective cutting or reforestation within the mangrove stand.

It is perhaps not likely that selective forest stewardship, such as that practiced in the Philippines, could work in the short term in Ecuador, due to the degree of extension services required and the predominance of multiple-use issues that require community, rather than individual decision-making. Stewardship concessions that specify the sequence of cutting and siting of cuts, and that enforce protection of seed trees are now thought to be the most promising approach, but still need testing. Provincial forestry management offices in the coast would have to be given adequate staffing and operating budgets to successfully administer such programs—something they certainly do not have at present.

Social forestry approaches are likely to be accepted in some parts of the coast, but are not likely to succeed without action-oriented research that builds a group able to provide appropriate technical advice and extension support. Otherwise, early failures will probably discourage long-term implementation.

The Inter-American Development Bank project will provide additional opportunities to improve services and gain experience in the four ZEMs with mangrove ecosystems. Many of the problems facing ecological tourism development relate to the formation or strengthening of small businesses. The PMRC and INEFAN may not be likely to succeed in actions that use local economic incentives, such as ecological tourism, that promise to be low-cost over the long run, but require skilled guidance on enterprise development—something the PMRC is not well-equipped to provide. In addition, the PMRC philosophy of self-development and community participation tends to encourage new and inexperienced groups to take on the complex task of providing high-quality recreation services. They will not be able to learn to do this quickly and, in some cases, will probably not be able to learn these skills at all.

Restoration of degraded areas and forestation of emerging islands in estuaries seems to function well technically, but there was considerable debate during the design of the Inter-American



Development Bank project as to their cost-effectiveness compared to natural regeneration, ecotourism, and enforcement measures. Yet for areas suffering more than 20 percent mangrove ecosystem loss—including all four ZEMs—the symbolic value of both restoration actions and mitigation by shrimp farmers or others found to be destroying a mangrove area may more than justify initial costs. Studies to demonstrate the economic and ecological value of mangrove ecosystems could be especially useful in resolving this debate and in setting numerical targets for Ecuador's estuaries.

Finally, Ecuador's inexperience with land and coastal area zoning casts doubt on the ease with which the PMRC can advance its own proposals. However, a breakthrough in mangrove area zoning, user agreements, or stewardship concessions could answer the critical question raised in the assessment of Strategy 3 by providing a feasible, lower-cost alternative to full-scale special area planning, creating long-term local efforts to achieve sustainable uses.

#### **Strategy 5. Prepare a national mangrove policy proposal.**

##### The mangrove working group and national policy proposals

Beginning in Project Year 7 (1991), the mangrove working group turned its attention to discussing the national policy implications of the ongoing ZEM planning and site-specific management actions. The National Commission on Coastal Resources Management encouraged the PMRC to advance this work. A workshop was held in Machala in 1992 that included INEFAN, and national environmental groups began to focus attention on the need for a basic new policy statement—one that not only permitted mangrove use, but relied on local stewardship as a fundamental policy for achieving sustainable use of the ecosystems.

The draft proposal for the first time identified policies that addressed both the objectives and the methods by which Ecuador should tackle the worsening problem of mangrove destruction:

- Develop multiple uses of mangroves that will not significantly alter the mangrove ecosystem resource base.
- Guarantee the development of mangrove vegetation to the level where optimal inputs and flow of energy is attained.
- Improve the efficiency in use of mangrove production at the community level.
- Involve communities in mangrove stewardship for sustainable use.
- Expand the area of mangrove ecosystem through forestation of emerging islands, sediment zones, and shrimp farm canals.
- Develop plans for basic and applied scientific investigation, taking into account the role of mangroves in the productivity of other coastal ecosystems.

The formation of all seven Ranger Corps will create a specific opportunity for developing strategic approaches to the enforcement of mangrove management laws, and will raise a whole host of governance issues. In the five estuaries covered by ZEM plans, this will be relatively easy, since the Ranger Corps units have worked in these sites for two to three years, are familiar with ZEM plan issues and priorities, and have already made important contributions by increasing patrols and enlisting local volunteer monitors.

Most of the largest mangrove systems are outside the ZEMs. Table 2 provides the outline for the different enforcement and stewardship strategies needed for these systems. A heavily damaged and conflict-ridden estuary such as Cojimíes-Bolívar-Chamanga may first require efforts to build awareness and support, perhaps linked to some restoration projects, rather than organizing local volunteer monitors. In San Lorenzo, where relatively little damage has occurred so far, the emphasis might be on interventions to prevent the initiation of indiscriminate cutting, rather than on extensive patrols. Estero Salado, near the city of Guayaquil, is under great pressure from urban development, and is fortunate to have a number of key institutions—such as INEFAN, CLIRSEN, and activist groups—who are interested in the preservation and conservation of mangroves, and might be encouraged to adopt and monitor the use of particular areas. In Taura, where mangroves are in relatively good condition, and play an important buffer and flood control role, government

Estuary	Possible strategy	Key tools
San Lorenzo (rios Santiago, Cayapas, Mataje) 22,859 ha Largely undisturbed Total loss: 3.5 percent	Establish sustainable use patterns; avoid the initiation of indiscriminate cutting, work in biological reserves.	Work with newly formed user groups, and regional and local authorities; conduct public education; develop a technical assistance team; conduct user group training in management methods; carry out local projects; hold working group meetings; build mechanisms for interinstitutional work; conduct investigation and monitoring.
Rio Atacames (Z) (R) 52 ha Heavily damaged Total loss: 9.5 percent	Protect remaining mangroves; conduct restoration and reforestation through ZEM committee.	Implement ZEM plan, including user group agreements, mangrove tourism
Rio Muisne (Z) (R) 1,375 ha Heavily damaged Total loss: 59 percent	Protect remaining mangroves; conduct restoration and reforestation through ZEM committee.	Implement ZEM plan, including reforestation, multiple-use management, user group agreements.
Near Rio Chone (Z) (R) 783 ha Complete destruction Total loss: 51.3 percent	Protect remaining mangroves; conduct restoration and reforestation through ZEM committee.	Implement ZEM plan, including conservation, restoration, and forestation.
Cojimies-Bolívar-Chamanga 3,448 ha Heavily damaged Total loss: 80.3 percent	Introduce the concept of mangrove protection and ecosystem restoration.	Conduct public education program to build awareness and support; carry out pilot projects on reforestation and shellfish habitat management.
Posorja (Z) 3,313 ha Moderately damaged Total loss: 10.9 percent	Protect remaining mangroves; conduct restoration and reforestation through ZEM committee.	Implement ZEM plan.
Estero Salado 40,846 ha Moderately damaged Total loss: 12 percent	Reduce rate of destruction; develop beneficial uses for the urban population.	Create protected areas managed by local groups such as DIGMER, Vendedores de Gas, Fundación Natura; conduct education campaigns.
Taura 19,583 ha Moderately damaged Total loss: 12 percent	Protect mangroves for flood control and collecting sediments, buffer zone, and wildlife habitat.	Identify institutions to take lead in protection—such as CEDEGE, DIGMER, and INEFAN—through Ranger Corps mechanism; develop cooperation with shrimp farmers.
Churute Reserve 12,209 ha Total loss: 4.3 percent	Continue successful protection and management program.	Manage as natural reserve with studies, patrols, and interpretation.
Naranjal 11,833 ha Heavily damaged Total loss: 25.1 percent	Protect remaining mangroves and promote management for sustainable use of crab fishery.	Conduct public education aimed at users, shrimp farmers, and communities; organize user groups; develop user group agreements; manage and improve crab fishery; develop tourism; conduct monitoring.
Jambelí (Z) (R) 5,625 ha Total loss: 52.8 percent	Protect remaining mangroves, restoration and reforestation through ZEM committee	Implement ZEM plan.
Hualtaco 13,630 ha Heavily damaged Total loss: 25.5 percent	Protect remaining mangroves, introduce restoration proposals	Conduct public education campaign; work with shrimp farmers; develop user group agreements and community management agreements; create plan for wood harvest; improve mangrove fisheries.

(Z) = Located in ZEM

(R) = Ranger Corps presence

Table 2. Possible strategies and tools to address mangrove management in Ecuador's principal estuaries.



institutions with interest in the ecosystem and management of the surrounding watershed—such as CEDEGE and DIGMER—might be more appropriate than small user groups to form an agreement on monitoring and enforcement.

#### The national mangrove management symposium and draft national policy statement

In July 1993, 100 representatives of government agencies and NGOs participated in a national mangrove management symposium. The workshop featured an update of the status of mangrove resources, agency views on policy directions, and an extensive presentation of the PMRC experience in testing sustainable use policies and techniques, as well as a field trip to the Churute Reserve. Working group sessions focused on four aspects of mangrove management: legal and administrative problems, public education, tourism, and community participation. The symposium filled an important gap in previous meetings by examining the feasibility of implementing new policies. A new burst of print and broadcast media coverage of the mangrove issue followed the symposium, which coincided with the PMRC receiving the "Blue Planet Award" for its work in mangrove conservation in Muisne.

Symposium participants agreed that a mangrove ecosystem conservation policy based on exclusively coercive enforcement is simply not implementable. The largest untapped source of energy and resources for mangrove management remains the self-interest of mangrove users, and an enlightened citizenry that appreciates and acts to maintain the values and functioning of a critical coastal ecosystem. The initial tests of new mangrove policies by the PMRC demonstrate that it is indeed possible to tap into this source of local power with relatively inexpensive techniques and projects.

Although the best solutions to the national mangrove management crisis may lie predominantly in mobilizing the efforts of communities and resource users, the path toward fulfilling this vision of coastal management will require decisive national leadership. The PMRC developed a draft text proposing a new mangrove management policy to the National Commission on Coastal Resources Management. The policy consisted of five key items essential to the improvement of mangrove management:

- Mangroves will be managed for sustainable use, guaranteeing conservation of the resource base.
- Participatory management techniques will be employed.
- Specific mangrove use plans for estuaries and ecosystems, based on local characteristics will be developed.
- The Ranger Corps and enforcement of mangrove conservation laws will be strengthened.
- The process for mangrove ecosystem administration will be transparent and accessible to the public and resource users.

In contrast to the first set of policies developed by the mangrove working group, primary emphasis was on the mechanisms by which the overall sustainable use philosophy should be carried out. The National Commission on Coastal Resources Management will consider adopting the policy statement, which then should be the subject of an interministerial agreement and published in the Official Register. In addition, the National Commission should develop criteria and serve as a forum for reviewing mangrove ecosystem management proposals for estuaries to ensure that these proposals are consistent with ZEM plans. During 1995, the PMRC worked with INEFAN to prepare new regulations for controlling the impacts of shore development on mangrove ecosystems.

A national mangrove ecosystem management strategy for Ecuador needs to be implementable, which suggests that it needs to have several important characteristics:

- A practical approach must address the entire problem, which in fact encompasses all of the estuaries, in order to avoid the collapse of additional places. The measures undertaken must be tied to the actual problems being faced; among the most important of these is the legacy of poor implementation at the local level. A practicable national strategy must permit flexibility in the selection of policies and actions to accommodate local circumstances.

- To produce an acceptable national policy, key actors at the national and local levels must be consulted, not only during policy formulation, but on a continuing basis.
- A feasible strategy must find low-cost methods of planning, decision-making and implementation, and address the question of what will happen after the initial intervention has been terminated. This is where investments in education, staff training, and awareness- and constituency-building efforts can have large returns, decentralizing decision-making.
- Finally, a national strategy must be monitored, and the results must be measurable. The ultimate test is whether mangrove ecosystems are improving, maintaining themselves, or continuing to degrade. If the national strategy cannot be held accountable for the status of the resource, it lacks a practicable design.

Estuary-wide or local strategies will have difficulty meeting the criteria of implementability without a supportive national context. An estuary strategy would not be practicable if national agencies failed to apply their legal authority and expertise to new agreements. This in turn requires that the strategy achieve acceptability, not only among resource users, but among the entities with administrative responsibility over the resource. Lack of national support for an initiative in an estuary might also diminish feasibility if key sources of financial assistance have to be sought through government initiatives.

#### Outcomes and assessment of the national mangrove policy proposal

The process for formulating a national mangrove policy has succeeded in placing the spotlight on mangrove ecosystem problems and on the need to confront implementation issues. Of particular importance is the acceptance of the PMRC role in developing alternatives to existing methods and in serving as a catalyst for policy reform. The PMRC will continue to lead this effort, attract funding, and supervise new planning and implementation efforts. The Inter-American Development Bank funding will continue the focus on demonstrating the feasibility of specific mangrove solutions within the ZEMs.

The creation of an effective system for mangrove management has involved the implementation of management actions that bring together scientists and national and international experts in ecology, forestry, public education, and planning. The new national policy proposal attempts to move beyond the ineffective "no use" policy, and shifts attention to site-specific plans for sustainable use and conservation. This approach has worked well in the ZEMs, raising new expectations for PMRC involvement in many other locations on the coast.

Modifying the national approach to mangroves needs to take place gradually, so that the integrated planning is done well, and implementation efforts are sustained, including making improvements to the legal, organizational, and coordination framework.

The practical exercises in the PMRC have shown the country how to integrate user groups and institutions. Advances made in Ecuador are now being examined and tried in other Latin American countries interested in trying to develop mariculture in a sustainable way.

The mangrove management plans in Ecuador must also emphasize the exchange of information and constant communication among managers, scientists, and user groups, in order to verify that management techniques work and to motivate practical efforts to reach national goals.

The PRMC, as a leader in the management process, must strengthen the mangrove working group and continue to sponsor national and regional workshops, seminars, and training events to keep examining Ecuador's experiences in light of international practices and knowledge.

Finally, it is essential to carry out a public education program that reaches all coastal residents. The contributions of NGOs should be recognized and encouraged, along with special recognition of the potential role of the private sector, since many investments that affect mangrove ecosystems are initiated by people living outside the regions where the projects occur.

